THE AIR-TELEGRAPH

SYSTEM OF TELEGRAPHING TO TRAINS AND SHIPS.

I HAVE been asked to write something about my new system of telegraphy by induction between moving railway trains and the usual fixed stations, which makes it possible to send messages through the air without attaching any wire to the cars or to the track.

The induction coil has long been known to electricians and studied by them, but its enormous practical value does not seem to have been understood. Indeed, this has hardly been suspected by those who have used the coil simply in scientific experiments. A number of years ago an induction coil was made, which had the power of throwing sparks a distance of twenty-one inches and making them penetrate solid blocks of glass three inches thick; and this was considered so remarkable that it is recorded as among the most striking of experimental achievements. But I arrived at something much more startling than that, in the course of some researches which I had undertaken for another purpose. For some years I have been at work looking for a new force, traces of which I have often observed in my study of electrical and other action—a force which is constantly present in many forms and places, but has never been measured, named or brought under control. I have devised dozens of machines to test this unknown force and ascertain its characteristics; and I have now planned a test which may, within a few months, give me a clear proof of its existence and put me on the trail by which I can follow it up and capture it.

While I was carrying on investigations upon this line, I found that, by means of an apparatus which I had made, I could throw a very strong electric current *fifty feet* through the air, from one conductor to another, by means of a simple primary coil which

gave no spark in the air, while the secondary coil connected therewith, although giving sparks through the air several inches in length, was powerless to transmit a wave over this great distance. This fact at once opened a whole new field for the practical use of induced electricity in telegraphing between points at which a wire connection would not be practicable. It was like finding suddenly a new volume of romance in the endless library of electrical wonders. Afterwards my friends, Mr. William Wiley Smith and Mr. E. T. Gilliland, came forward with an invention patented by them in 1881, for working the telephone by means of induced currents to and fro between railroad cars and a special wire near the track. We combined our resources, and I went on experimenting—having discarded the telephone and adopted Morse characters—until, beginning with a leap of the current through fifty feet of air, I am now able to send it five hundred and eighty feet. Hence it appeared that no special wire would be needed close to the track, because the current generated on the car could jump over to the regular Morse wires; and these wires were used by me, through the employment of proper instruments, to convey messages to their destination, without interfering with the regular traffic. The result of work by Mr. Gilliland and myself, in inventing, perfecting and adapting apparatus, is that a circuit can now be established between any train, either moving or at a stand-still on a railroad, and the terminus of the road; or between the trains and any station on the route. A circuit is also established between any one train and all other trains on the same road.

It would be out of place, here, to give all the details of the apparatus by which this is accomplished. The current generated on the car proceeds from a small five-cell battery placed under a table (or cabinet, as we call it), about two feet square, which holds the instrument. The table affords room for a Morse key, an electro-magnet and an instrument called a "vibrator," which, by means of a metal reed, gives a musical character to the electrical impulses caused by opening and closing the circuit. At the termini, or at any fixed station, all that is needed is a similar apparatus, with a twelve-cell battery and a wire connection with three or four of the regular telegraph wires. On the car the wires from the battery and instrument are grounded through the axles and wheels. Another wire leads up to the ordinary metal roof of the

car and charges it with electricity. The roofs of the several cars composing a train may also be connected by an insulated copper wire. In this way the roof acts as one side of a condenser, and the usual telegraph wires stretched on poles along the edge of the road-bed form the other side of the condenser. The current from the car battery and the roof of the car is of such a nature that the wave of electricity sent from the apparatus in the car lasts only about one 500,000th of a second. During this short period the air seems to conduct electricity; but if the current were allowed to remain any longer the air would enter into such a state as to oppose any further transmission. If now an interval of time is allowed to elapse the air regains its normal condition and another wave can be transmitted. In sending a single Morse letter, for instance the letter E, which is a single dot, over fifty separate waves with waits between them have to be transmitted, at the rate of six hundred per second. Those separate, rapid waves form a musical sound. A long or short depression of the key of an organ imitates the sound of the dots and dashes as heard in the receiving instrument. The operators, both on the car and at the fixed stations, hear these notes through telephonic sounders, so that the rattle of the train and the crackling noise of other messages rushing along the wires do not disturb them in the least. All that they hear from these receivers is a clear, crisp, humming note which is perfectly distinct in its short or long iterations. The operator on the car has the telephonic receivers fastened over his ears by a rubber strap, so that both hands remain free, one to work the key with and the other to write out messages as they arrive. The regular Morse waves traverse the wires at the rate of about thirteen to a second. Mine go through the air and along the wires at the rate, as I have said, of six hundred a second. This does not make it possible to send a message any more rapidly than on the regular Morse circuits; but it effects one result of the highest importance—that is, that one current does not interfere with the other. The sounds which we transmit by inductive electricity cannot be heard by operators at ordinary Morse instruments; but any average operator at a fixed station provided with our instrument can read our messages with even greater ease than he could read from the customary relay instrument.

Hence it makes no difference how many wires there may be along-side the railroad. No confusion is possible. Neither can

car operators take messages off those wires when sent by means of ordinary currents. But messages sent by our apparatus from one train to another, or from trains to stations, can travel over the usual circuits without difficulty. Dispatches can be sent to or from the cars in either direction, either forward or backward along the route. The current leaps over to and runs along the wires, and whatever train or station may be called, that train or station will hear the call and answer it, but others which are not called will, of course, make no reply. Two trains passing each other on the road will not materially interrupt communication, because they pass within a few seconds, and the telegraphing to and from each one can be resumed immediately.

The expense of putting instruments in on cars or at stations will be small. No special wire will ever be needed except in extreme cases where regular wires diverge widely from the road-bed. The instruments on trains will occupy only a corner in either a baggage or a passenger car, and they can be moved from one car to another and set going again within a few minutes after the transfer. The advantage of this system over any which involves running a costly insulated wire between the rails or close to them is apparent in the fact that, while a single special wire could easily be cut by mischievous persons, nothing could break communication by our system, unless all the regular telegraph wires should be torn down. Furthermore, a wire running along the track would be apt to be injured by any accident to a train at the very moment when it would be essential to talk to that train. Under my system every train would be sending reports to the fixed stations all the time; so that even if the car in which the instrument was placed were to be overturned, it would not matter. The operators and train dispatchers would at once suspect an accident and telegraph accordingly to other trains.

This invention might well be called "the air-telegraph," because we are able by it to converse through the atmosphere from the wires. But the company to which it now belongs calls it simply the "railway telegraph." I expect to apply it in such a way that ships at sea, many miles apart, can exchange messages of any length by signals. This will, probably, be accomplished by using a balloon-kite coated with tin-foil, soaring several hundred feet above the deck and controlled by a fine wire. The song of the Sirens would have no charm for any mariner who could hear from

home and send word to his sweetheart by this method. News of wrecks, distress, mutinies, etc., could be rapidly forwarded from ship to ship within each other's signalling area, and merchants could not only find out just where the ships are that carry valuable cargoes invoiced to them, but could also, if they desired, telegraph to alter the destination of their vessels, in accordance with changes of the market. In time of war a line of ships stationed along the coast or between the scene of active hostilities and the nearest telegraph office, could be of immense service in conveying by the "air-telegraph" news of the enemy's approach, or in transmitting dispatches where communication by the land routes was interrupted. In archipelagos and where small islands lie near the coast, this device would make it possible to telegraph from island to island or to the main shore much more cheaply than by laying submarine cables. Why should we not also use the same means for telegraphing from stations at long intervals, which might be set up in mountain or forest regions, which the wires do not commonly penetrate?

But it is not necessary to dwell on these and other uses to which the invention may be put in the future. There is one application of it which at present transcends all others and has been tried fully on the Staten Island Railroad. Before these pages are published it will also be in operation on the Chicago, Milwaukee and St. Paul Railroad, where its value in train-dispatching will be illustrated. I am not familiar with the management of railroads, but some of those who are so assure me that the "air-telegraph" or railway telegraph will greatly facilitate railway service in the following ways:

1. On roads having a large traffic, it is more economical to dispatch freight trains (except in some cases of line and special freights) as soon as they are made up, and to allow them to make their run without being bound by a fixed schedule. A special and important instance of this is the way in which trains loaded with grain have to be sent from the West to the East as rapidly as possible. Any method that enables the train department to move such trains safely without a fixed schedule must be invaluable. On a single-track road, especially, with telegraph stations some distance apart, it is essential that the train department should watch and control the movements of trains so as to keep them clear from all dangers and collisions. As things are now, the chief train dispatcher is like a general trying to conduct a campaign and to move

his various corps and divisions when communication with them for a large part of the time is cut off. The new system will give him absolute command of the whole field.

2. Besides moving trains under favorable conditions, the dispatcher has to contend with many serious difficulties in case of untoward events. Among these difficulties are "wrecks," damage to the roads, snow blockades, foggy weather, "broken trains," etc. All such obstructions cause grave disturbance, and necessitate the issuing of immediate orders. Under the existing system a long delay occurs before a report of the obstruction is received; even then the train dispatcher has only a faint idea of all the circumstances; and he cannot send his orders swiftly or to the best advantage. The new method obviates all this trouble and uncertainty. The moment anything goes seriously wrong on the roads either the operator on the train which has met with the accident, or the operator on the train nearest to it, telegraphs to the dispatcher. The dispatcher at once calls through his instrument for a report from every train, and in a few minutes he obtains full knowledge of the state and position of each train on his division. Having once got these data, he solves his problem at the shortest notice.

3. It must also be borne in mind that a delay in sending perishable goods, or in making fast expresses keep time, frequently causes a railroad a loss of many thousands of dollars for a single stoppage. The new system will prevent this loss. Prompt telegraphing to and fro will make it possible to run trains of superior class, or trains containing perishable goods, around other trains which cause the delay.

4. Dispatchers, by this system, can call up any and all trains, whether in motion or on a siding. And if a train, in accordance with schedule, has taken a siding, to wait until another train passes it, the dispatcher can order it to go ahead without regard to the other train, which meanwhile has been held back by his orders sent directly to it.

The usefulness of the invention is not confined to train-dispatching, however. It is evident that it can be employed to great advantage for ordinary telegraphic correspondence, whenever it is important that a message should be sent to some one on a train, whose destination is two or three days' travel distant from his starting-point. Sudden changes in the aspect of business affairs,

which require that a traveling agent or partner should be notified before he reaches his station, may be explained to him by the railway telegraph, while he sits in the car journeying along at the rate of thirty or forty miles an hour. Similarly he may send back to his office in New York, San Francisco or Chicago any information which he happens to pick up, or business decisions which he was not able to make before starting.

The benefit to newspaper correspondents is obvious. They can collect news at one town, and on their way to another place they can write their dispatches in the train and send them from it directly to the editorial office, wherever that office may be, thereby saving a great deal of time.

Police business will of course be greatly expedited by this system. The police authorities of any town or city, if they have reason to suppose that a criminal or a civil offender—such as embezzlers and confidence men—has taken to flight by railroad, can at once send descriptions and inquiries to all trains on the routes leading from their locality.

The working of the invention is not a matter of uncertainty. It is already developed and perfected, and can be applied anywhere. I have had it elaborately tested for several months, and it operates equally well in all weathers. So completely is it under control that, I think, by fastening metallic plates on houses near the regular lines of telegraph wires, offices could be opened in those houses, and an opposition telegraph system be started on the same wires. It is possible that I may in time find means of using telephones on trains, for oral conversation, which was the original idea of Mr. William Wiley Smith; but that would be a separate development. The new railway telegraph is complete, as it stands to-day; and, in its new utilization of induced electricity, as well as in its wide-spread, practical bearings, it seems to me—if I may speak of it for a moment without regard to my personal relation to it—one of the most important among recent inventions, in the results it is likely to accomplish.

THOMAS A. EDISON.